6. a. Each stage has seven times as many segments as the previous stage, and each segment is $\frac{1}{5}$ the length of segments in the previous stage.

	Total length		
Stage number	**Multiplication form**	**Exponent form**	**Decimal form**
0	1	1^0	1
1	$7 \cdot \frac{1}{5}$	$7^1 \cdot \left(\frac{1}{5}\right)^1 = \left(\frac{7}{5}\right)^1$	1.4
2	$7 \cdot 7 \cdot \frac{1}{5} \cdot \frac{1}{5}$	$7^2 \cdot \left(\frac{1}{5}\right)^2 = \left(\frac{7}{5}\right)^2$	1.96

b. $\left(\frac{7}{5}\right)^{20} \approx 836.68$

7. No matter what value you start with, the result approaches 5, so the attractor is 5.

Take Another Look

The behavior of numbers raised to a power depends on the kinds of numbers involved.

Number in box	Exponent of 3 (or any odd integer greater than 1)	Exponent of 4 (or any even integer greater than 0)
Positive number greater than 1	Bigger	Bigger
Negative number less than -1	Smaller (negative yet farther from 0)	Bigger (becomes positive)
0 or 1	Stays the same	Stays the same
-1	Stays the same	Bigger (becomes 1)
Positive fraction between 0 and 1	Smaller (positive yet closer to 0)	Smaller (positive yet closer to 0)
Negative fraction between 0 and -1	Bigger (negative yet closer to 0)	Bigger (becomes positive)

The statement "If the denominator of a fraction increases, the value of the fraction decreases" is true for positive fractions written with both numerator and denominator positive. For negative fractions—written with only the numerator negative—increasing the denominator makes the magnitude of the fraction decrease, thereby moving it closer to zero. Because the fraction moves to the right along the number line, it becomes greater.

For $\frac{\bigcirc}{\square^3}$ to be smaller than $\square^3$, the numerator would have to be less than $\square^6$ if the number in the box is positive.

For $\frac{\bigcirc}{\square^3}$ to be greater than $\square^3$, the numerator would need to be greater than $\square^6$ if the number in the box is positive.

For $\frac{\bigcirc}{\square^4}$, the numerator would be compared to $\square^8$.

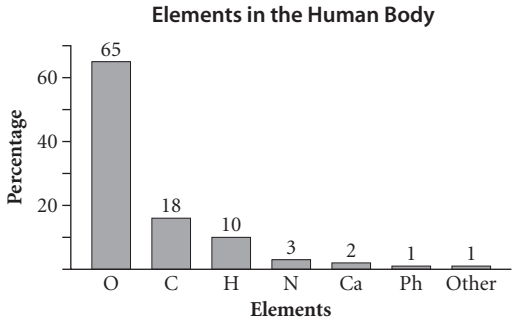
CHAPTER 1

LESSON 1.1

Exercises

1. Max: 93 bpm; min: 64 bpm; range: $93 - 64 = 29$ bpm.

2. The categories in this problem are the elements (note that the chemical abbreviations are used in the graph below). Percentages are shown on the vertical axis. The height of each bar represents the percentage for that element.



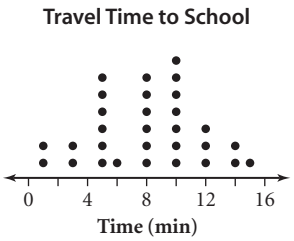
3. a. Jupiter (There are 38 named satellites.)

b. Mercury and Venus have no satellites.

c. $38 - 8 = 30$ more satellites.

d. $30 \div 2 = 15$ times as many satellites.

4. a. Draw a number line to represent the times. Your number line will need to include values from at least 1 (the minimum time) to 15 (the maximum time). Make a column of dots over each time to represent the number of students who take that much time to get to school. For example, because two people spend 3 minutes traveling to school, there are two dots over the number 3.



b. To find the total number of students, add the numbers of students in the table, or count the dots. There are 30 students in the class.

c. To find the combined time, multiply each time by the number of students who take that long to get to school. Then, add the results: $2 \cdot 1 + 2 \cdot 3 + 6 \cdot 5 + 1 \cdot 6 + 6 \cdot 8 + 7 \cdot 10 + 3 \cdot 12 + 2 \cdot 14 + 1 \cdot 15 = 241$. So, the combined time is 241 min, or 4 h and 1 min.

d. To find the average, divide the combined time by the number of students. The average is $\frac{241}{30} \approx 8$ min.

5. a. 80 bpm (the number with the tallest column of dots)

b. $93 - 64 = 29$ bpm

c. Answers will vary. She probably counted her pulse rate for one full minute.

d. Any whole number could occur, not just multiples of four.

e. A full minute, sometimes longer, to ensure accuracy.

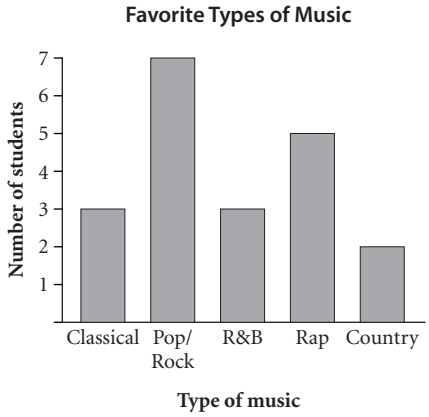
6. a. Graph iii is the best match. The values in graphs ii and iv are too large. Graph i has some values of 0, which cannot be correct because at least one person (the student) must live in each student's home.

b. Graph ii is the best match. The values in graphs i and iii are too small. The values in graph iv seem too large. The shortest person represented in that graph is 5 ft 8 in., the tallest person is 6 ft 5 in., and more than half the students are over 6 ft tall!

c. Graph iv is the best match. The values in the other graphs are too low.

d. Graph i is the best match. The values in the other graphs are too large.

7. Knowing there are 3 students in the R&B category, you can see that there are 2 in Country, 5 in Rap, and 7 in Pop/Rock. That leaves 3 in Classical to reach the known total of 20 students.



8. A bar graph because the information falls into categories, is not numeric data, and cannot be scaled on a number line.

9. a. Answers will vary. Possible answer: Jonesville's Varsity Basketball Team.

b. Answers will vary. Possible answer: Jonesville's Kindergarten Class and their Teacher.

c. Answers will vary. Possible answer: Jonesville's Algebra Class.

d. Answers will vary. Possible answers: Group A: Everyone in the school is very tall. Group B: Most people in the school are very short. Group C: Jonesville School is a high school only.

e. Graphs will vary.

10. a. 10^4 **b.** $2^3 \cdot 5^6$ **c.** $\frac{3^6}{8^3}$

11. a. $7 + (3 \cdot 2) - 4 = 7 + 6 - 4 = 9$

b. $8 + 2 - 4 \cdot 12 \div 16 = 8 + 2 - 48 \div 16 = 8 + 2 - 3 = 7$

c. $1 - 2 \cdot 3 + 4 \div 5 = 1 - 6 + 0.8 = -5 + 0.8 = -4.2$

d. $1 - (2 \cdot 3 + 4) \div 5 = 1 - (6 + 4) \div 5 = 1 - 10 \div 5 = 1 - 2 = -1$

e. $1^2 \cdot 3 + (4 \div 5) = 1^2 \cdot 3 + 0.8 = 1 \cdot 3 + 0.8 = 3 + 0.8 = 3.8$

12. a. Double 225 until you go past 4050. Double 1 the same number of times.

Doubles of 225	**450**	900	1800	**3600**	7200
Doubles of 1	**2**	4	8	**16**	32

Find doubles of 225 that add to 4050: $450 + 3600 = 4050$. Then, add the corresponding doubles of 1: $2 + 16 = 18$. So, $4050 \div 225 = 18$.

b. Double 6 until you get past 57.

Doubles of 6	**6**	12	24	**48**	96
Doubles of 1	**1**	2	4	**8**	16

Look for doubles of 6 that add to 57. There is no combination that works. The closest you can get is $6 + 48 = 54$. You need 3 more to get to 57. Because 3 is half of 6, find half of 1 as well. Add these values to the table:

3	**6**	12	24	**48**	96
1/2	**1**	2	4	**8**	16

Because $3 + 6 + 48 = 57$, you can find the quotient by adding the corresponding "doubles" of 1: $0.5 + 1 + 8 = 9.5$. So, $57 \div 6 = 9.5$.

13. $\frac{1}{16} + \frac{1}{16} + \frac{1}{4} = \frac{3}{8}$

Improving Your Reasoning Skills

Perhaps JoAnn's graph illustrates low temperatures better, because negative values fall under the axis, but her graph makes it hard to compare the low temperatures. However, the side-by-side feature of Janet's graph allows easy comparison between high and low temperatures.

LESSON 1.2

Exercises

1. a. To find the mean, add the values and divide by the number of values. The sum is 54, and there are 9 values. So, the mean is $54 \div 9 = 6$.
To find the median, list the values in order: 1, 3, 5, 5, 6, 7, 8, 9, 10. The median is the middle value, which is 6. The mode is 5, the value that occurs most often.

b. The mean is 51 ÷ 10 or 5.1. Order the list to find the median: 1, 2, 3, 3, 4, 6, 7, 8, 8, 9. The median is the average of the middle two numbers (4 and 6), or 5. The modes are 3 and 8.

c. The mean is 82 ÷ 8 = 10.25. Order the list to find the median: 2, 5, 6, 7, 11, 12, 18, 21. The median is 9. There is no mode.

d. Mean: 17.5; median: 20; mode: 20

2. a. Read the data values from the graph. The number of dots above a number indicates the number of times that number occurs in the data set. So, the values are 1, 1, 1, 2, 2, 2, 3, 4, 5, 6, 6, 6, 8, 9, 9. The mean of this data is $\frac{65}{15} \approx 4.3$. The median is 4. There is no mode because there are too many most common values.

b. Mean: $\frac{53}{15} \approx 3.5$; median: 2; modes: 1 and 2

3. a. To find the number of students, just count the dots. Twenty student responses are shown.

b. Range = maximum − minimum = 8 − 0 = 8

c. 1 (the number with the tallest column of dots)

4. a. Mean: $\frac{161 + 205 + 215 + 310 + 420}{5} = \frac{1311}{5} =$ 262.2 ft; median: 215 ft

b. Mean: $\frac{155 + 195 + 206 + 300 + 400}{5} = 251.2$ ft; median: 206 ft

5. The average cost $= \frac{\text{total bill}}{\text{number of items}}$, so you can find the total bill by multiplying the average cost by the number of items. This gives you 16 · 1.14 = 18.24, making the total bill $18.24.

6. a. Mean: 97.485 m; median: 60 m

b. The median is the most appropriate measure of center. The mean is affected by the extreme value of 525.

7. The first three members averaged 53 seconds each, so together they took 53(3), or 159 seconds. The total time for the whole team must be 50(5), or 250 seconds. The two remaining members must have a total of 250 − 159, or 91 seconds. So, the last two people must average 91 ÷ 2, or 45.5 seconds each.

8. The mean, 83.8, is lower than all but one of his scores. The median, 88, is more representative.

9. Answers will vary. If the speaker is talking about the entire state, this cannot occur. All scores cannot be greater than the middle score. In fact, exactly half of the scores will be above, and half will be below, the median.

10. a. The mean weight $= \frac{\text{total weight}}{\text{number of fish}}$; you can find the total weight by multiplying the mean weight by the number of fish. So, the total weight is 1527.4 · 10 or 15,274 lb.

b. Five of the fish caught weigh 1449 lb or less, and five weigh 1449 lb or more.

c. Maximum = minimum + range = 991 + 1673 = 2664. So, the maximum weight is 2664 lb.

11. Answers will vary. Sample answers are provided.

a. When the five data values are listed in order, the third value must be 12. Because the mean of the five values is 19, the total value must be 19 · 5 or 95. So, the remaining values must add to 95 − 12 or 83, and there must be two values less than 12 and two values greater than 12. One possibility is {8, 10, 12, 32, 33} years.

b. When the six values are listed in order, the mean of the two middle values is 4, and the value 5 must occur most often. One possibility is {2, 3, 3, 5, 5, 5} people.

c. {7, 14, 20, 21, 24, 27, 27} points

12. a. (*See graph at bottom of page.*)

b. Mean: 32.65; median: 30; mode: 28

c. The median probably summarizes the data best. The mean is distorted somewhat by the extremely high value of 74.

13. a. Because the data is numeric, a dot plot may be most appropriate. However, if each value were translated into years (divide by 12), you could make a bar graph or pictograph with ages as categories.

b. Answers may vary. (*See graph at bottom of next page.*)

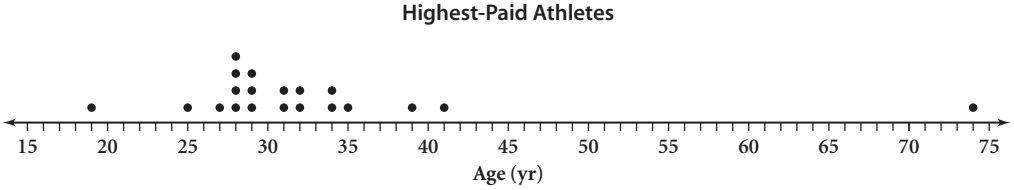
14. a. 12 cm **b.** 8 cm **c.** 2.4 cm

LESSON 1.3

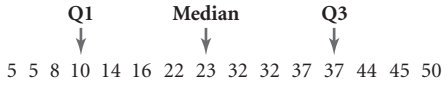
Exercises

1. a. The minimum is 5 and the maximum is 50. The median is the middle value, 23. The first quartile (Q1) is 10, the middle value in the first half of the data. The third quartile (Q3) is 37, the middle

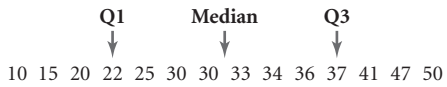
Lesson 1.2, Exercise 12. a.



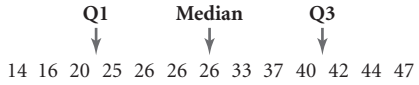
value in the second half. So, the five-number summary is 5, 10, 23, 37, 50.



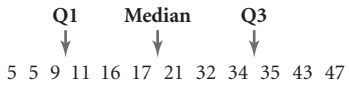
b. The minimum is 10 and the maximum is 50. Because there are an even number of values, the median is the number halfway between the two middle values, 30 and 33. So, the median is 31.5. The first quartile (Q1) is 22, the middle value in the first half of the data. The third quartile (Q3) is 37, the middle value in the second half of the data. The five-number summary is 10, 22, 31.5, 37, 50.



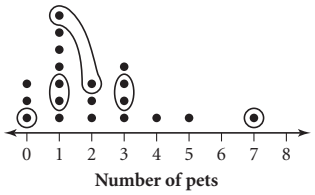
c. 14, 22.5, 26, 41, 47. The values are listed in order below with the location of the median and quartiles indicated.



d. 5, 10, 19, 34.5, 47. The values are listed in order below with the location of the median and quartiles indicated.



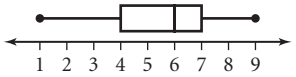
2. a. i. There are 20 data values. Listed in order, they are 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 3, 3, 3, 3, 4, 5, 7. The median is the value halfway between the tenth and eleventh values, which are 1 and 2. The first quartile is the median of the 10 values in the first half of the data. So, it is the number halfway between the fifth and sixth values, which are 1 and 1. The third quartile is the median of the 10 values in the second half of the data, so it is the number halfway between the fifteenth and sixteenth values, which are 3 and 3.



ii. (*See graph at bottom of page.*)

b. i. 0, 1, 1.5, 3, 7 **ii.** 64, 75, 80, 86, 93

3. The five-number summary is 1, 4, 6, 7, 9. To create a box plot, make dots over the minimum and maximum values. Draw vertical segments over the median and quartiles. Draw a box with ends at the first and third quartiles. Draw horizontal segments that extend from each end of the box to the minimum and maximum values.



4. Choices a and d are both possible. Both have the five-number summary shown in the box plot. Choice b has the correct minimum, median, third quartile, and maximum, but the wrong first quartile. Choice c has the correct minimum, first quartile, median, and maximum, but the wrong third quartile.

5. a. Answers will vary. Quartiles are the boundaries dividing a data set into four groups, or quarters, with approximately the same number of values.

b. The range

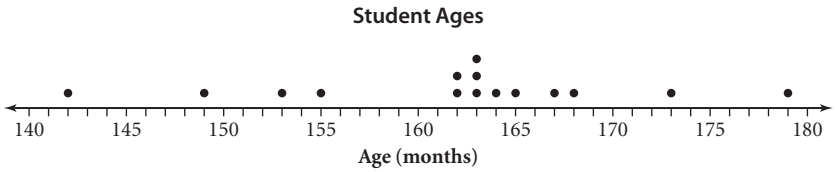
c. The interquartile range, or IQR

d. Outliers are at or near the minimum and maximum values, which are the endpoints of the whiskers.

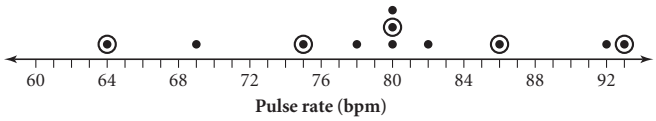
6. a. Answers will vary. The prediction should be less than the mean.

b. Because the mean of the four scores is 25.5, the total must be $4 \cdot 25.5$, or 102. The sum of the three scores Stu knows is 79, so the third score must be $103 - 79$, or 23 points.

Lesson 1.2, Exercise 13. b.



Lesson 1.3, Exercise 2. a. ii.



c. The four scores are 23, 23, 27, and 29. The five-number summary for this data set is 23, 23, 25, 28, 29.

d. Answers will vary. Because there are only four values, a five-number summary may be inappropriate—the values themselves illustrate the spread of the data.

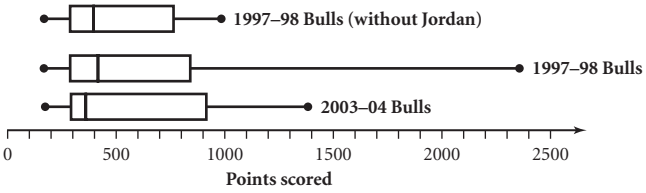
7. a. 173, 292, 360, 915, 1383

b. The mean for the 1997–98 Bulls is about 675 points, and the mean for the 2003–04 Bulls is about 564 points; the medians are 416 points and 360 points, respectively. The means are both much higher than the medians because both teams have a few players that score very high. However, the 1997–98 mean is much higher than the 2003–04 mean because Michael Jordan scored so many total points.

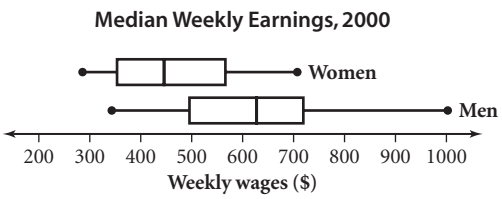
c. The median probably best represents the total-points-scored data for the 1997–98 Bulls. Students can justify choosing either the mean or the median for the 2003–04 Bulls. As a team owner, you might think the mean better reflects your team's talents.

d. The box for the 2003–04 Bulls is longer, indicating that more of the team members are grouped toward the center. The minimum number of points scored by a player is about the same, but the maximum is much higher for the 1997–98 Bulls.

e. Without Jordan, the range of the data is much smaller and the box is a little shorter than the complete data for the 1997–98 Bulls. The box plot for 1997–98 without Jordan is more like the one for the 2003–04 Bulls than that for the complete 1997–98 Bulls team.



8. a. Answers will vary. For men, the mean salary is approximately \$639.56, and the five-number summary is 342, 495, 629, 718.5, 1001; for women, the mean salary is approximately \$466.69, and the five-number summary is 288, 353, 445, 563.5, 708.



b. Women received less pay than men for the same type of work.

c. The box plots highlight the discrepancy in pay and spread of the data. However, dollar amount comparisons within a single profession are possible only in the table.

d. Answers will vary. The table shows that women are not paid as much as men, so people interested in gender equity are asking for equal pay for equal work.

9. a. 35 ft

b. No. We cannot read the sixth value from the graph. We can see that the median—which is between the fifth and sixth value—is 17.5, and that the third quartile—which is the eighth value—is 25. So, we do know that the length of the king cobra is greater than or equal to 17.5 ft and less than or equal to 25 ft.

c. 65 mi/h

d. The ten longest snakes vary in length from about 8 ft to 35 ft. About half of these snakes range in length from about 11 ft to 25 ft. Running speeds of the ten fastest mammals range from 42 mi/h to 65 mi/h. About half of the speeds are between 43 mi/h and 50 mi/h. The cheetah runs much faster than about three-fourths of the other fastest mammals.

e. No, because the units of these data sets are different.

f. The median is halfway between the fifth and sixth values. Because these values are the same, the median must be equal to these values. From the graph, we can see that the median is about 47. So, the fifth and sixth fastest mammals can run about 47 mi/h.

10. a. $1.5(841 - 288) = 829.5$

b. $288 - 829.5 = -541.5$

c. $841 + 829.5 = 1670.5$

d. An outlier would have to score fewer than -541.5 points or more than 1670.5 points. Michael Jordan is an outlier.

11. When the ages are listed in order, the third value is 14. The total of all ages must be $5 \cdot 22$ or 110 years. One possibility is {4, 10, 14, 39, 43}.

12. a. 2 million · number of paw prints = 2 million · 38 = 76 million

b. There are 7.5 more paw prints next to "Cat." Each paw print represents 2 million animals. So, there are $7.5 \cdot 2$ million, or 15 million more cats than dogs.

c. There are 21 million small mammals, and there would be one paw print for every 2 million. So, there would be 21 million ÷ 2 million, or 10.5 paw prints.

LESSON 1.4

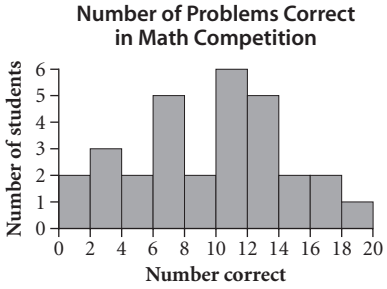
EXERCISES

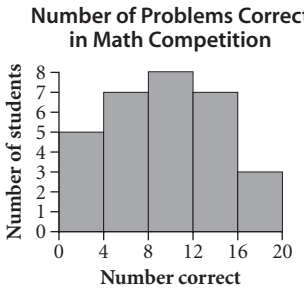
1. a. To find the number of people surveyed, add the heights of the bars. For the matinee, the sum is 3 + 4 + 4 + 6 + 4 + 5 + 2 + 1, or 29. For the evening performance, the sum is 2 + 6 + 8 + 7 + 6 + 1, or 30.

b. Matinee **c.** None

d. Any 15-year-olds surveyed would be in the age 10–20 bin. You can't determine exactly how many (if any) of those four respondents were exactly 15 years old. You can say for certain only that the number is less than or equal to 4.

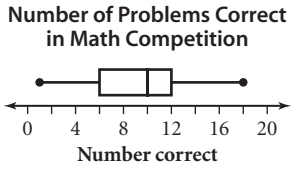
2. a. Possible graphs:





b. Answers will vary. Student scores tended to be in the middle of the range.

c. 1, 6, 10, 12, 18



d. 7 and 12

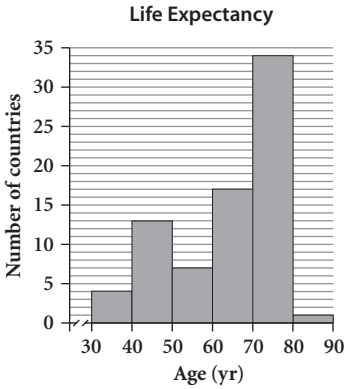
3. a. To find the number of countries represented, add the bin heights: 2 + 2 + 5 + 8 + 3 + 4 + 7 + 10 + 18 + 16 + 1 = 76.

b. Approximately one fourth of the countries had a life expectancy between approximately 69 and 74 yr.

c. 24

d. There are no bins to the right of 85 in the histogram. Also, the maximum point in the box plot is located at approximately 83 yr.

4.



5. a. Minimum: 6.0 cm; maximum: 8.5 cm; range: 2.5 cm.

b. Put the ones digits in the stem. Use the tenths digits as the leaves.

Ring Finger Length

6	0 5 5
7	0 0 0 5
8	5

Key

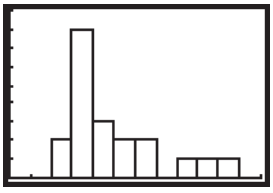
6 | 0 means 6.0 cm

6. a. 24 · 10,000, or 240,000 cars

b. Two models sold between 80,000 and 119,999 cars, inclusive.

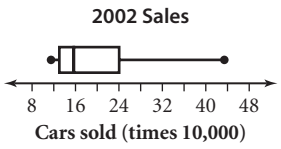
c. [0, 480000, 40000, 0, 9, 1]

d.



e. An approximate five-number summary is 115000, 131000, 157000, 241000, 434000. The actual five-number summary is 115428, 130650, 157278.5, 240712, 434145.

f.



7. Answers will vary.

a. With a bin width of 1, the bin heights should be about the same (because each number has the same chance of being rolled) with about 16 or 17 in each of six bins.

b. There will probably be a few short bins at the ends for students who estimated poorly and then taller bins near the middle for students whose estimates were closer to the actual measurements.

c. The horizontal axis should show the range of ages for students in the school. The heights of the bins should be about the same. There may be a few students who are younger or older than most of the rest of the students, so there could be shorter bins on the ends.

d. The combined height of the first two bins (2–3 and 3–4) should be a little less than 25. The combined height of the next four bins (4–5, 5–6, 6–7, 7–8) should be a little more than 25. The last two bins (8–9 and 9–10) should each have a height of 25.

8. a. The minimum is 1, the maximum is 9, and the median and both quartiles are 7. The data set must be {1, 7, 7, 7, 7, 7, 7, 9}.

b. Answers will vary. Each value must be greater than or equal to 5 and less than 6. One possible data set is {5, 5, 5, 5, 5, 5, 5, 5}.

c. Because there is one value in each bin, there is one value greater than or equal to 1 but less than 2, one value greater than or equal to 2 but less than 3, and so on. One possible data set is {1, 2, 3, 4, 5, 6, 7, 8}.

d. The minimum and Q1 are both 2, and the maximum and Q3 are both 4. The median is equal to either 2 or 4. There are two possible data sets: {2, 2, 2, 2, 2, 4, 4, 4} or {2, 2, 2, 4, 4, 4, 4, 4}.

9. a. Answers will vary. You could give the top two students As, and the next seven (down to 15 points) Bs. Those students with 9 to 15 points would get Cs, and the bottom three students would get Ds. This scheme allows those students who score in the center to get a C.

b. Using the grading scheme described above, the student gets an A.

c. Answers will vary.

10. a. Look at the lowest stem value, 15, and read the lowest leaf, 0. This value represents the lowest price, \$1.50.

b. Chips priced \$1.75 and \$1.79

c. Stem values from 15 through 19 represent the chips priced at \$1.99 or less. So, to find the number of bags priced less than \$2, count the leaves on those stems. There are 14 bags priced less than \$2.

d. Look for the leaf that occurs the most times on a single stem. The leaf 9 occurs five times on the 19 stem, so the most common price is \$1.99.

e. \$2.59 − \$1.50 = \$1.09

11. a. Hospital A's histogram is mounded toward the left. Hospital B's histogram is mounded toward the right. Hospital C's histogram has all bins of equal height. Hospital D's histogram is mounded in the middle.

b. Hospital A had more shorter waiting times and fewer longer waiting times. Patients at Hospital B had fewer shorter waiting times and more longer times. There were an equal number of patients in each time range at Hospital C. At Hospital D, the largest number of patients had waiting times of 20–25 minutes; as the waiting time gets farther from that central value, there are fewer and fewer patients.

c. Answers will vary. No patients at Hospital B had to wait longer than 30 minutes, while approximately 40% of patients at Hospital A had to wait longer than 30 minutes. However, few patients at Hospital B waited less than 10 minutes, while almost 20% of patients at Hospital A waited less than 10 minutes.

d. Answers will vary. Students might prefer Hospital B because all patients were seen in less than 30 minutes. At Hospital A, many patients were seen in less than 20 minutes, but some patients had to wait a very long time.

12. a. Ida weighed the apples from the market, which are more uniform in weight, and Mac weighed the backyard apples, which vary more widely.

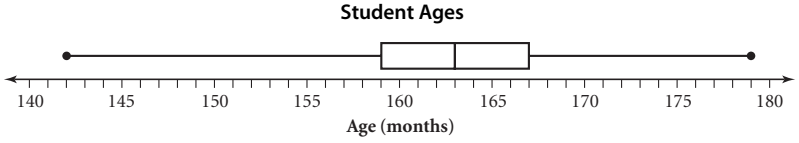
b. Mac's apples had a greater variety of weights. They were less uniform than Ida's apples.

c. Both of the histograms are shaped like mounds, higher in the middle and decreasing to the sides. For both kinds of apples, more apples have weights close to the mean weight, and fewer apples have weights farther from the mean.

13. (*See graph at bottom of page.*)

14. Answers will vary. The **bold** values are fixed. One possibility is {**64,** 70, 74, 80, **82, 82, 82, 82, 95**}.

Lesson 1.4, Exercise 13.



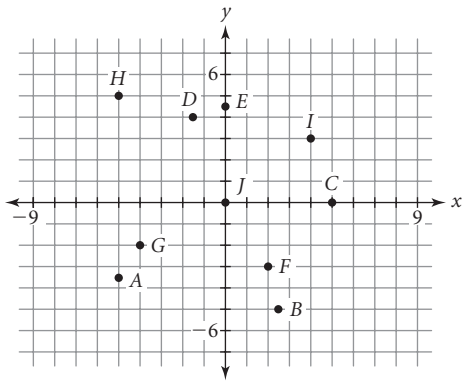
LESSON 1.5

Activity day: There are no answers for this lesson.

LESSON 1.6

EXERCISES

1.



2. a. Positive *x*-axis **b.** Quadrant II
c. Quadrant I **d.** Quadrant III
e. The origin **f.** Negative *y*-axis

3. All work is done on the calculator.

4. Answers may vary slightly.

a. On the curve, find the point with *time* value 2. The *distance* value for the point is about 2. The walker was about 2 m from the sensor.

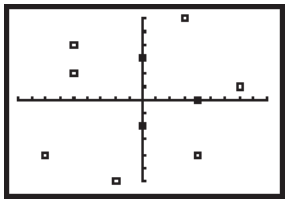
b. The lowest point on the curve has the smallest distance value. This point has a *time* coordinate of about 5. So the walker is closest to the sensor after about 5 s.

c. About 2.7 m

d. Look for "flat" portions of the curve, where the distance value does not change for a period of time. The walker stopped for about one second between 4.5 and 5.5 s and paused at the beginning between 0 and 1 s.

5. a. $A(-7, -4)$, $B(0, -2)$, $C(3, 6)$, $D(0, 3)$, $E(4, -4)$, $F(-2, -6)$, $G(4, 0)$, $H(7, 1)$, $I(-5, 2)$, and $J(-5, 4)$

b.



c. *B, D,* and *G*

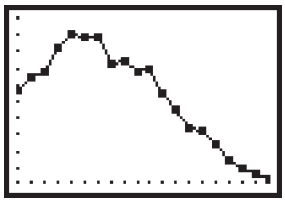
d. I: *C* and *H*; II: *I* and *J*; III: *A* and *F*; IV: *E*

6. Scatter plot descriptions will vary. However, the location scenarios should include information such as (*positive, positive*) in Quadrant I; (*negative, positive*) in Quadrant II; (*negative, negative*) in Quadrant III; (*positive, negative*) in Quadrant IV; (0, *any number*) on *y*-axis; (*any number,* 0) on *x*-axis, and (0, 0) as the origin.

7. a. Approximate answers (the second coordinates are in millions):

(1984, 280), (1985, 320), (1986, 340), (1987, 415), (1988, 450), (1989, 445), (1990, 440), (1991, 360), (1992, 365), (1993, 340), (1994, 345), (1995, 275), (1996, 225), (1997, 175), (1998, 160), (1999, 125), (2000, 75), (2001, 45), (2002, 30), (2003, 15)

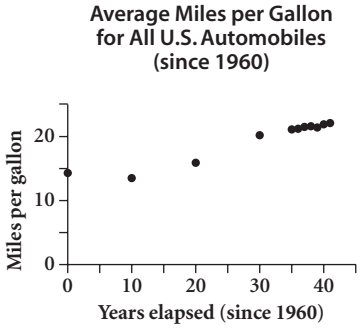
b. Window [1984, 2003, 1, 0, 500, 50]



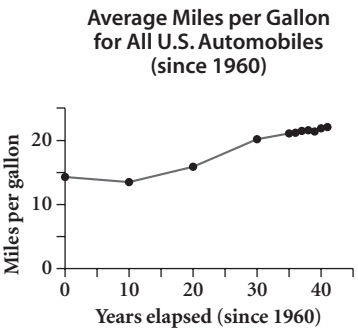
c. Answers will vary. Shipments increased until 1988 and then decreased except for a slight increase in 1992 and 1994. The introduction of compact discs may have influenced the decrease.

8. a. Years elapsed are 0, 10, 20, 30, 35, 36, 37, 38, 39, 40, 41.

b.

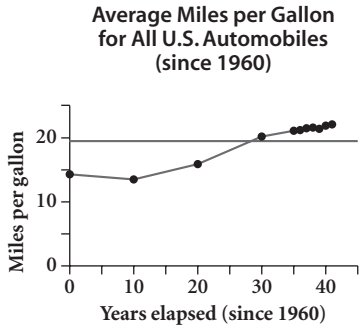


c.



d. Approximately 19.5 mpg

e.



The horizontal line separates the data points that are above the mean of the averages from the data points that are below it.

f. Answers will vary.

9. a. $(-1.5, 2.6)$, $(-3, 0)$, $(-1.5, -2.6)$, $(1.5, -2.6)$

b. Answers will vary.

10. a. 8:06 (The speed drops suddenly at this point.)

b. 40 mi/h **c.** 12 min

d. Answers will vary. It seems unrealistic that Xavier's dad never fully stopped during the trip.

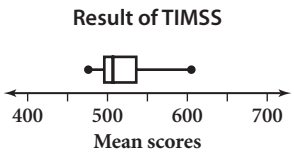
11. a. The **bold** values are fixed. One possibility is {**5, 12,** 14, **15,** 20, **30, 47**}.

b. The **bold** values are fixed. One possibility is {**5,** 10, **12,** 13, 14, 16, 20, **30,** 40, **47**}.

c. The **bold** values are fixed. One possibility is {**5,** 10, 12, 12, 13, 14, 16, 20, 28, 32, 40, **47**}.

12. a. The five-number summary is 476, 496, 506.5, 536, 605.

b.



c. The greatest spread is between the third quartile and the maximum, that is, the right whisker. The least spread occurs between the first quartile and the median.

d. The interquartile range is $536 - 496 = 40$ points.

e. Between first quartile and median: Scotland, England, Sweden, Lithuania, United States, Australia; above the third quartile: Belgium, Japan, Taiwan, Hong Kong, Korea, Singapore

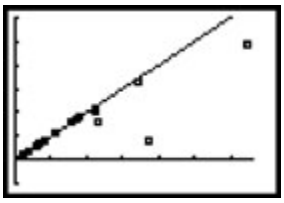
Improving Your Reasoning Skills

The weather glyphs show four variables: cloud coverage, wind direction, wind speed, and time. Time is definitely a numeric variable. Wind direction, cloud coverage, and wind speed, however, could be argued as either numerical or categorical. Wind direction might be assigned a compass bearing. Cloud coverage could be three categories, or be assigned a percentage (0%, 50%, 100%), or be assigned a degree number (1, 2, 3). Wind speed is also complex because although a specific numeric wind speed would be measured (e.g., 6 knots), it would then be placed in a categorical bin (e.g., 3–7 knots). A variety of graphs can display this data, but it may be hard to find a single type of graph to display all the information.

LESSON 1.7

Exercises

1. a. Window: [0, 70, 10, −10, 60, 10]. (The lower Ymin value allows trace numbers to appear on the calculator screen without interfering with plotted points.)



b. $y = x$

c. No. In no case is the estimated number of dinosaurs more than the actual number.

d. Yes. For five species, the estimated count is less than the actual count.

2. a. The points below the line—*B, C, E, F,* and *J*—represent Lucia's estimates.

b. The points above the line—*A, D, G, H,* and *I*—represent Malcolm's estimates.

3. Overestimates are points for which the *y*-coordinate is greater than the *x*-coordinate. These points are *B, C, D, E,* and *G*. Underestimates are points for which the *y*-coordinate is less than the *x*-coordinate. These points are *A, F, H,* and *I*.

4. a. Possible approximations are

Time	0	0.5	1.0	1.5	2.0
Distance	0	0.5	0.8	1.4	2.1

Time	2.5	3.0	3.5	4.0	4.5
Distance	2.7	3.0	3.6	3.9	4.25

b. Answers will vary. A minimum window is [0, 5, 1, 0, 5, 1].

c. $y = x$

d. Increasing

5. a. Answers will vary. The more the rubber band is stretched, the farther it flies.

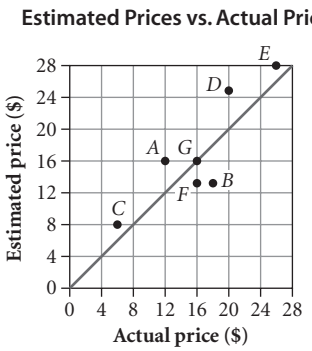
b. Answers will vary between 400 and 600 cm. For a point with *x*-coordinate 15 to fit the pattern in this graph, the point would need to have a *y*-coordinate between 400 and 600.

c. Answers will vary between 7 and 12 cm. For a point with y-coordinate 400 to fit the pattern in this graph, the point would need to have an x-coordinate between 7 and 12.

6. a. For such a point, the actual price is 12 and the estimated price is 16. The point is A (12, 16).

b. For such a point, the actual price is 18 and the estimated price is 13. The point is B (18, 13).

c. Point C is an overestimate of \$2, point D an overestimate of \$5, and point E an overestimate of \$2.



d. (*See graph for 6c.*)

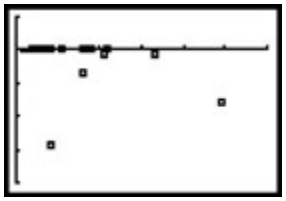
e. On a horizontal line through the estimate \$16 on the vertical axis

f. On a vertical line through the actual \$16 on the horizontal axis

g. They are points on the line shown. These points indicate points for which *estimate = actual price.*

7. a. It shows the differences between the estimated number of each species and the actual count. This helps identify overestimates and underestimates.

b. Window: [0, 60, 10, −40, 10, 10]



c. 5; for the points below the x-axis, the y-coordinate, *estimated number − actual number,* is less than 0, so the estimated number is less than the actual number. They represent underestimates.

d. (8, −29); the 8 is the estimated number of velociraptors; the number of velociraptors was underestimated by 29.

8. a. (−4, 1) **b.** (−2, −5) **c.** (1, 5)

d. Plotted points will vary. In general, they lie on the line that bisects Quadrant II and Quadrant IV. The equation $y = -x$ fits these points.

9. a. If a point lies on the line $y = x$, it means the verbal score is equal to the mathematics score.

b. These states also have high verbal scores. The verbal scores are not as high as the math scores.

c. Because more points are below the line than above it, more states had students with higher mathematics scores than verbal scores.

10. a. About 1 m/s, because the distances in meters are about equal to the times in seconds.

b. Between 0.5 and 1.0, between 2.5 and 3.0, between 3.5 and 4.0, between 4.0 and 4.5. For these intervals, the change in the distance values is less than the change in the time values.

c. Between 1.0 and 1.5, between 1.5 and 2.0, between 2.0 and 2.5. For these intervals, the change in the distance values is greater than the change in the time values.

d. Between 0 and 0.5, between 3.0 and 3.5. For these intervals, the change in the distance values is about equal to the change in the time values.

11. a. Answers will vary. The mean of the values is 125.0 cm, and the median is 125.3 cm.

b. Answers will vary. The string is longer than the stick, so you would need to measure twice or fold the string. The string will have some stretch, so it would be hard to keep it straight without stretching it. The ends of the string are never "clean" cut, so you would have to choose "the end."

c. It means that this measure is accurate within 0.2 cm.

d. Answers will vary. The range of measures is 123.3 to 126.5. This could be written 124.9 ± 1.6 cm.

12. Answers will vary.

a. The median must be equal to one of the quartiles. One possible answer is {1, 3, 3, 3, 4, 5, 6}.

b. The first and third quartiles must be the same. One possible answer is {1, 4, 4, 4, 4, 4, 7}.

c. The minimum value must be less than Q1 − 1.5 · IQR. One possible answer is {1, 6, 6, 7, 7, 8, 9}.

d. The third quartile and the maximum value must be the same. One possible answer is {1, 2, 3, 4, 5, 6, 6}.

13. a. The data values need to be organized in increasing order. The key should show an actual value from the data set.

b.

13	5 8
14	2 6 7 9
15	2 5 7 7 8 8
16	2 2 4 4 5 8
17	1 3 3 3 6
18	2 4

Key

13 | 5 means 13.5 cm

c. 18.4 − 13.5 = 4.9 cm

LESSON 1.8

EXERCISES

1. Matrix [A] shows the 1992 statistics. Row 2 represents Randall Cunningham. Column 3 represents the number of touchdown passes. So, the entry in row 2, column 3, of matrix [A] tells you that Randall Cunningham threw 19 touchdown passes in 1992.

2. Steve Young made 322 pass completions in 1998.

3. 3×4

4. Answers will vary.

5. $\begin{bmatrix} 788 & 489 & 35 & 19 \\ 809 & 492 & 53 & 21 \\ 919 & 590 & 61 & 19 \end{bmatrix}$

This matrix gives the totals from the two years.

6. Yes. This result should always be true if the matrices have the same dimensions.

7. $\begin{bmatrix} -158 & -115 & -11 & -9 \\ 41 & 26 & 15 & -1 \\ 115 & 54 & 11 & 5 \end{bmatrix}$

This matrix gives the difference between the 1998 totals and the 1992 totals.

8. $([A] + [B]) \cdot \left(\frac{1}{2}\right)$

Note: The calculator expression $([A] + [B])/2$ will produce an error message because division is not defined for matrices.

9. a. $\begin{bmatrix} 8 & -5 & 4.5 \\ -6 & 9.5 & 5 \end{bmatrix}$ Add corresponding entries.

b. $\begin{bmatrix} -3 & 4 & -2.5 \\ 2 & -6 & -4 \end{bmatrix}$ Change each entry in [A] to its opposite.

c. $\begin{bmatrix} 15 & -3 & 6 \\ -12 & 10.5 & 3 \end{bmatrix}$ Multiply each entry in [A] by 3.

d. $\begin{bmatrix} 4 & -2.5 & 2.25 \\ -3 & 4.75 & 2.5 \end{bmatrix}$ Add corresponding entries and then multiply each result by $\frac{1}{2}$.

10. $[B] = \begin{bmatrix} -2 & 0 \\ 6 & -11.6 \\ 4.25 & 7.5 \end{bmatrix} - \begin{bmatrix} 2.8 & 2.4 \\ 2.5 & -9.4 \\ 1 & 6 \end{bmatrix}$

$= \begin{bmatrix} -4.8 & -2.4 \\ 3.5 & -2.2 \\ 3.25 & 1.5 \end{bmatrix}$

11. Answers will vary. Possible problem: Find the labor costs of building an item using 16 hours billed at \$5.25 per hour and 30 hours billed at \$8.75 per hour. The product is

$[5.25 \quad 8.75] \cdot \begin{bmatrix} 16 \\ 30 \end{bmatrix} = [5.25 \cdot 16 + 8.75 \cdot 30] =$

$[84 + 262.50] = [346.50]$.

12. a. Quantity matrix: $\begin{bmatrix} 74 & 25 & 37 \\ 32 & 38 & 16 \\ 120 & 52 & 34 \end{bmatrix}$

Profit matrix: $\begin{bmatrix} 0.90 \\ 1.25 \\ 2.15 \end{bmatrix}$

The number of columns in the quantity matrix must be the same as the number of rows in the profit matrix.

b. Atlanta profit:
$74(\$0.90) + 25(\$1.25) + 37(\$2.15) = \$177.40$

Decatur profit:
$32(\$0.90) + 38(\$1.25) + 16(\$2.15) = \$110.70$

Athens profit:
$120(\$0.90) + 52(\$1.25) + 34(\$2.15) = \$246.10$

c. $\begin{bmatrix} 177.40 \\ 110.70 \\ 246.10 \end{bmatrix}$; 3×1

d. The answer matrix gives the profit at each location.

Location	Profit
Atlanta	\$177.40
Decatur	\$110.70
Athens	\$246.10

e. The error message—ERR: DIM MISMATCH—means that the dimensions of the matrices in the product don't match.

13. a. Answers will vary. The minimum must be 0 and the maximum must be 7. Also, the data value 2 must occur more frequently than any other. A sample solution is {0, 1, 2, 2, 2, 2, 3, 4, 6, 7}.

b. Answers will vary. The minimum must be 22.2 and the maximum must be 30.4. No value in the list should occur more often than any other value. A sample solution is {22.2, 24.5, 25.1, 26.2, 28.3, 28.7, 29.4, 30.4}.

14. a. The 40 leaves to the left of the stem represent Mrs. Shapiro's students. The 41 leaves to the right represent Mr. Chin's students. So, there are 40 students in Mrs. Shapiro's class and 41 in Mr. Chin's class.

b. Mrs. Shapiro's: \$1.35; Mr. Chin's: \$1.25.

c. 13

d. In Mrs. Shapiro's class, one student had \$1.35 and one student had \$1.30.

e. Answers will vary. Based on the stem plot, you might expect Mrs. Shapiro's class to have more money. There are more students with more than a dollar in her class and more with less than 50¢ in Mr. Chin's class.

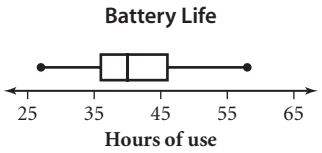
f. Mr. Chin's: \$20.34; Mrs. Shapiro's: \$24.96.

CHAPTER 1 Review

Exercises

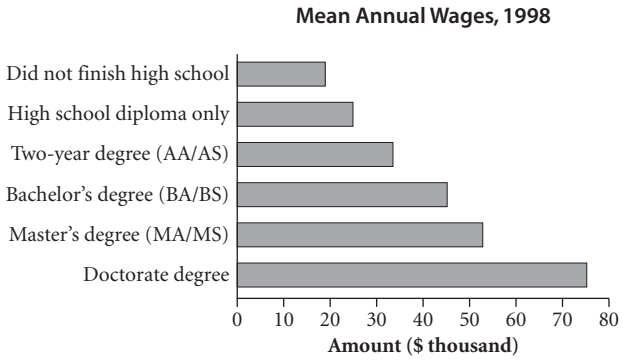
1. a. Mean: 41.5; divide the sum of the numbers by 14. Median: 40; list the numbers in order and find the mean of the two middle numbers. Mode: 36; find the number that occurs most often.

b. 27, 36, 40, 46, 58



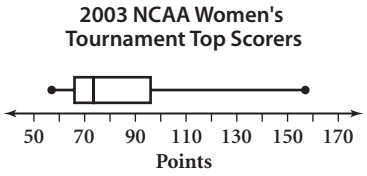
2. The five-number summary gives us five of the seven values. We need only fill in the blanks in this ordered data set {9, 11, –?– , 16, –?– , 21, 22}. Because the mean of the seven values is 16, the sum of the values must be $7 \cdot 16 = 112$. The values we have so far have a sum of 79, so the missing values must add to $112 - 79$ or 33. The values 14 and 19 add to 33, so one possible data set is {9, 11, 14, 16, 19, 21, 22}.

3. a.



b. Greatest difference: from a master's degree to a doctorate; smallest difference: from not finishing high school to a high school diploma.

4. a.

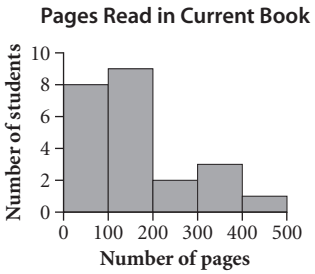


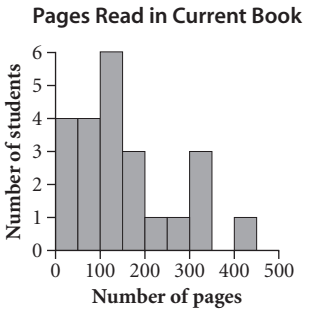
b. Diana Taurasi, with 157 points, is an outlier.

c. Answers may vary. The measures of center are mean, 83.9; median, 73.5; and modes, 66, 74.

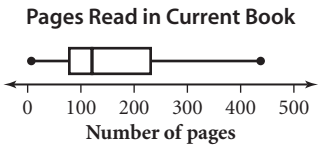
5. a. Mean ≈ 154; median = 121; there is no mode.

b. Bin widths may vary.



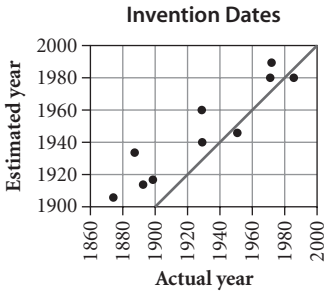


c.

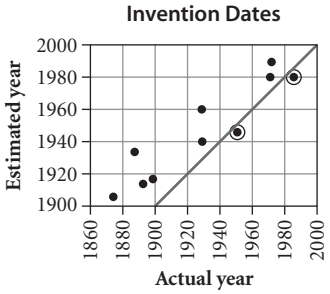


d. Answers will vary. Possible answer: Most of the students questioned had read fewer than 200 pages, with a fairly even distribution between 0 and 200.

6. a.



b.



c. $y = x$, where x represents actual year and y represents estimated year.

7. a. $\begin{bmatrix} 5.00 & 8.00 \\ 3.50 & 4.75 \\ 3.50 & 4.00 \end{bmatrix}, \begin{bmatrix} 0.50 & 0.75 \\ 0.50 & 0.25 \\ 0.50 & 0.25 \end{bmatrix}, [43 \quad 81 \quad 37]$

b. Add the matrix of current prices and the matrix of price increases.

$$\begin{bmatrix} 5.00 & 8.00 \\ 3.50 & 4.75 \\ 3.50 & 4.00 \end{bmatrix} + \begin{bmatrix} 0.50 & 0.75 \\ 0.50 & 0.75 \\ 0.50 & 0.25 \end{bmatrix} = \begin{bmatrix} 5.50 & 8.75 \\ 4.00 & 5.00 \\ 4.00 & 4.25 \end{bmatrix}$$

c. Multiply the attendance matrix by the new price matrix calculated in 7b.

$$[43 \quad 81 \quad 37] \begin{bmatrix} 5.50 & 8.75 \\ 4.00 & 5.00 \\ 4.00 & 4.25 \end{bmatrix} = [708.5 \quad 938.5]$$

The revenue from a matinee will be \$708.50. The revenue from an evening show will be \$938.50.

8. a. Kayo was jogging fastest between points *A* and *B* because she covered a lot of distance in a short period of time.

b. Kayo was not moving; perhaps she was resting.

c. Possible answer: Kayo started out jogging fast but had to rest for a few minutes. Then she jogged much slower until she had to rest again. She finally got the energy to jog all the way home at a steady pace without stopping.

9. a. 2,900,000

b. (*See graph at bottom of page.*)

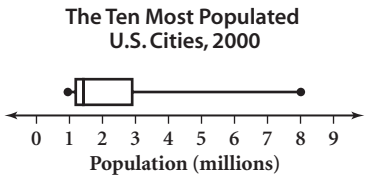
c. **The Ten Most Populated U.S. Cities, 2000**

0	95
1	14 19 22 32 52 95
2	90
3	69
4	
5	
6	
7	
8	01

Key

2 | 90 means 2.90 million

d.



e. The bar graph helps show how each city compares with the others, since they remain identified by name. The stem plot shows distribution, but also shows actual values. The box plot shows distribution and a clustering between 1 and 1.4 million, but does not show individual city names or populations.

10. a. Mean = 416.875 min

b. Median = 425 min **c.** Mode = 480 min

Take Another Look

The picture bar graph uses both a broken vertical axis (starting at 15) and pictures with decreasing area to exaggerate the decline of green space. The normal bar graph, on the other hand, measures only acres and neglects the ratio to the increasing population, which the first bar graph does. Therefore, both of the bar graphs are engineered to persuade. Answers will depend on whether you think acres per person or total acres is a better measure.

CHAPTER 2

LESSON 2.1

Exercises

1. Increasing order: b, a, d, c

Decimal values:

a. $\frac{7}{8} = 0.875$ **b.** $\frac{13}{20} = 0.65$

c. $\frac{13}{5} = 2.6$ **d.** $\frac{52}{25} = 2.08$

2. a. There are fourteen 9th graders (9 + 3 + 2). Nine of the 9th graders have brown eyes, so the ratio is $\frac{9}{14}$.

b. $\frac{11}{20}$ **c.** $\frac{4}{3}$ **d.** $\frac{3}{30}$, or $\frac{1}{10}$

Chapter 1 Review, Exercise 9. b.